The Xtal Set Society Newsletter

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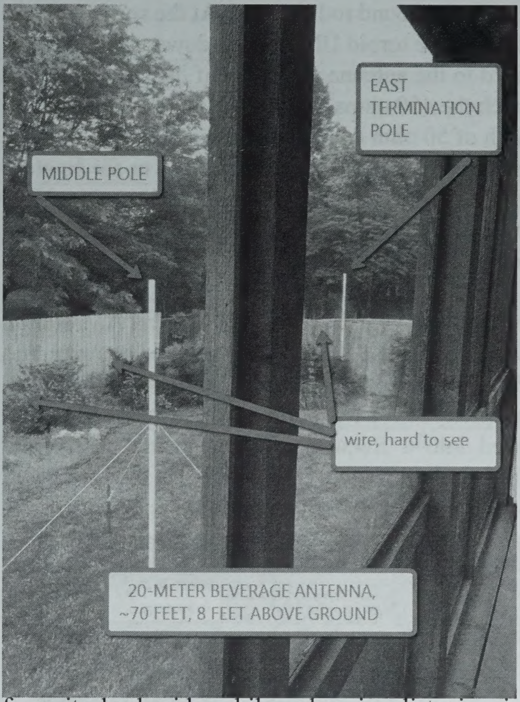
A Short Two-Way Beverage Antenna Project

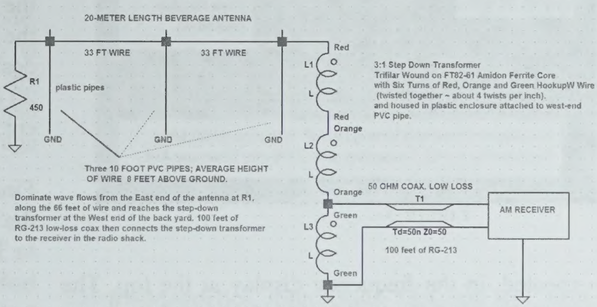
By Phil Anderson, WØXI

I live in a suburban neighborhood and about two blocks from a shopping center. The city population is nearly 100,000. As such, you can imagine the reference noise level for AM and shortwave reception for each band of interest is not as quiet as a typical rural setting would be. My back yard is only 70 feet wide and 50 feet deep, thus reducing the selection of useable antennas. Furthermore, the city height limit for antennas in my neighborhood is 33 feet! My solutions so far to improve reception have been to install a 33 foot SteppIR vertical for 40 through 10 meters and a 40-meter dipole up 22 feet.

One traditional way to reduce the noise level (floor) is to install a directional antenna. These reduce the signals received from the back side, including noise, while enabling desired signals in the forward direction with some gain. Yet, towers, rotors and a Yagi antenna are costly and perhaps disturbing for the neighbors. Hence I decided to try the age old Beverage antenna, invented in 1921 by Harold Beverage. The Beverage antenna is often referred to as a traveling wave antenna. It was popular in the early days, circa 1920, and more recently on 160 meters by licensed radio amateurs.



The Beverage, like the modern Yagi, reduces signals from its back side while enhancing listening in the direction it's pointed. Results so far have been gratifying. I've made two-way CW contacts with radio amateurs in Europe and listened to US AM stations in the 8 to 10 MHz range.



3:1 Step Down Transformer
Trifilar Wound on FT82-61 Amidon Ferrite Core
with Six Turns of Red, Orange and Green HookupW Wire
(twisted together ~ about 4 twists per inch).
and housed in plastic enclosure attached to west-end PVC pipe.

Three 10 FOOT PVC PIPES; AVERAGE HEIGHT OF WIRE 8 FEET ABOVE GROUND.

Dominate wave flows from the East end of the antenna at R1, along the 66 feet of wire and reaches the step-down transformer at the West end of the back yard. 100 feet of RG-213 low-loss coax then connects the step-down transformer to the receiver in the radio shack.

Figure 1 depicts my first Beverage and supporting equipment. The antenna consists of the following: 70 feet of antenna wire strung out 8 feet above the ground from northeast to southwest (for contact with Europe from Kansas) supported by three 10 foot PVC Poles. On the northeast end, a 450 ohm terminating resistor is attached to a ground rod as noted. At the southwest end a 3-to-1 ferrite toroid UNUN step-down transformer is attached to the antenna at the top of the pole; its job is to match the 450 ohms of the traveling wave antenna to a length of 50 ohm coax going to my station. I've used this setup with my K3 Elecraft transceiver for amateur radio use, both two-way CW and AM listening. Next month I plan to try a step-up transformer into a crystal set for HF shortwave listening.

Figure 3 displays a frequency plot of an AM station received by my K3 Elecraft transmitter-receiver and P3 Panadapter at 9980 kHz via the Beverage antenna. Panadapters convert a portion of the radio spectrum received into a frequency display using an internal digital signal processor (DSP). Note that the bandwidth of the AM station shown in the figure is 10 kHz wide, as expected, in the frequency display at the top. The bottom half of the figure displays the waterfall, showing the 10 kHz signal amplitude over a short period of time.

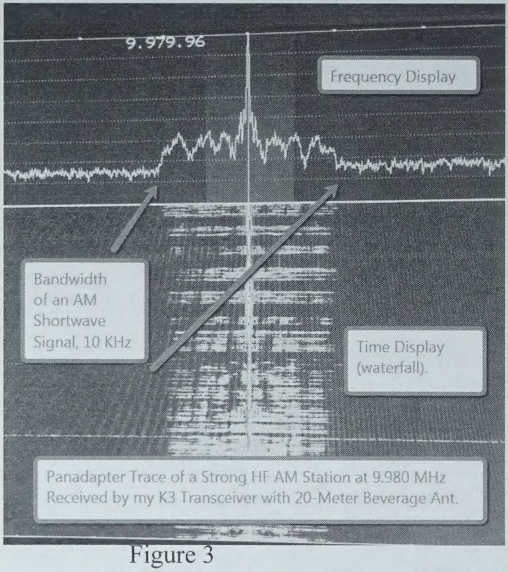

9.979.96
Frequency Display
Bandwidth of an AM Shortwave Signal, 10 KHz
Time Display (waterfall).
Panadapter Trace of a Strong HF AM Station at 9.980 MHz Received by my K3 Transceiver with 20-Meter Beverage Ant.

Figure 3

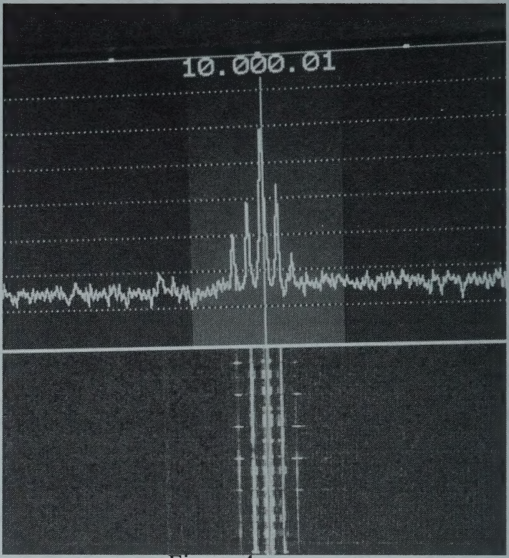


Figure 4

Figure 4 displays the Panadapter processed signal of WWV at 10 MHz. The carrier and sidebands represent the tones sent before the usual period of clicking that follows.

Results of my noise reduction efforts so far using the Beverage versus the Vertical antenna are noted in Table 1. While the results vary a bit given the time of day and from day to day, the results listed have been consistent. The only band that does not see at least an S unit and a half of background noise reduction is 15 meters. This is due, in part, to the natural reduction in cosmic and storm noise with increase in the frequency of reception. There is just less noise as one tunes the higher HF bands. The one anomaly is the fall off in improvement on 40 meters (7020 kHz). This is due in part to the length of the Beverage, only 70 feet, compared to the wavelength of the frequency in use. In addition, I designed the step-down ferrite toroid transformer for 20 meters, indicating that a few more turns or a different ferrite material for 40 meters might be helpful.

Finally, I checked the standing wave ratio (SWR) of the Beverage for the bands and specific signals listed in Table 2. Note that the SWR is below 2 to 1 for all bands except 80 and 160. This confirms that the UNUN transformer and 450 ohm resistive load match the 8 foot up/ 70 foot long Beverage well.

Table 1

FREQ in (kHz)	BAND	Noise Level via P3 for Beverage (dBM)	Noise Level via P3 for Vertical (dBm)	P3 Difference Beverage minus Vertical (dBm)	Equivalent Reduction in S Units	Wavelength % of Beverage Length
21020	15	-132	-125	-7	-1.16	133
18077	17	-132	-123	-9	-1.50	117
14040	20	-119	-109	-10	-1.66	100
10120	30	-127	-111	-16	-2.66	67
7020	40	-117	-103	-14	-2.33	50

Recall that S9 is at -73 dBm, S1 is at -121 dBm and S units are spaced 6 dBm apart up to S9.

My first two-way HF Beverage contact was on 20 meter CW, 6/2/2015, with Gary, VE2GDI, in Quebec, Canada. He sent me a 57N signal report and I returned with a 55N. The noise level reported in my P3 Panadapter attached to the K3 (Elecraft) was 8 to 9 dBm below that obtain with my SteppIR vertical, as expected, given the directionality of the Beverage. The P3 reported noise level for the vertical was -105 dBm and for the Beverage varied between -112 and -115 dBm, nearly two S units down! My second Beverage two-way contact was with YN5SU on 17 meter CW, at 5 PM, 6/4/2015. He gave me a 55N. My output power was 10 watts into the Beverage.

What's next? My plans at this time are to rework the 450 ohm terminating resistor for 100 watt operation, and also rework the 3-to-1 ferrite transformer for 100 watts if necessary. I've been limiting CW transmission to 10 watts until I can complete that rework. I also plan to do further testing on using the Beverage as a second receive antenna in diversity reception mode. Initial attempts have been successful, transmitting on the SteppIR vertical at 100 watts and listening in my left headphone to the transmit antenna for side tone and receiving and in my right headphone to the Beverage fed via the second receiver in the Elecraft K3.

Table 2

Frequency {MHz}	Band {Meters}	SWR, Measured (with Autek VA1) antenna analyzer
1.800	160	4.40
3.500	80	2.56
5.000	WWV	1.82
7.000	40	1.54
7.050	40	1.49
10.000	WWV	1.54
10.100	30	1.44
14.000	20	1.20
14.050	20	1.18
15.000	WWV	1.20
18.068	17	1.18
21.000	15	1.45

References:

Receiving Wave Antennas, Page 13-16, Chapter 13, The ARRL Antenna Book, 20th Edition, 2003-2005.

http://www.qsl.net/aa3px/beverage.htm. Google the web for the many articles about Harold Beverage and current work on Beverages by radio amateurs.

Electro-Magnetics, John Kraus, McGraw Hill, page 477. 1953. An Engineering text.

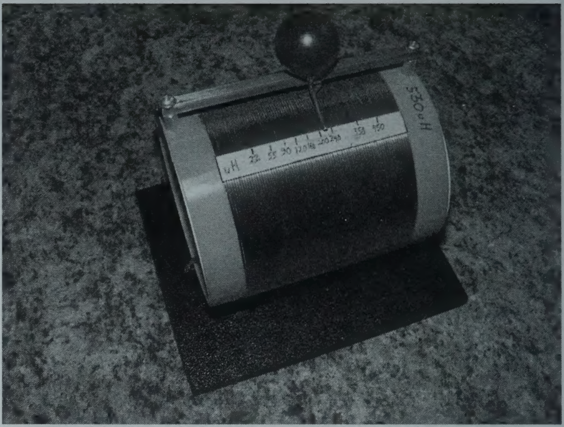
Antennas, John Kraus, McGraw Hill, pages 149, 412, 1950. An Engineering text.

Slip Slidin' Away (With apologies to Paul Simon)

by Dan Petersen - W7OIL

In the article I wrote for the May. 2015 issue I discussed practical (perhaps unavoidable) wire antennas for the property and covenant challenged, like I am now. Gone are the days of the "RMS Titanic" antenna on hilltop acreage. Now it's "hide everything from the yard-nazis", those roving do-gooders that will nark on their best friend for the chance to feel smug. I have an antenna on the roof now that is hard to see from six feet away, much less from the ground. To put the last article in a nutshell, unless your antenna is *more* than 138 feet in length electrically it will have a capacitive reactance component. Now to make the antenna resonant at BCB frequencies you will need to add a series inductance to cancel out the reactive component. The point where the inductive and capacitive reactances are equal is called *resonance*. The easiest way to make a variable coil is to make a *slider*. The one I built is made from a 5-inch length of 4-inch PVC pipe. I was hoping for winding 88 turns of #18 enameled wire for a 630 microhenry coil but I ran out of wire at 77 turns. So I ended up with a coil of 530 microhenries. It will still work for experimental purposes.

One thing you must remember is that your results most definitely will vary. If your antenna is shorter than my 65 foot one you will need more inductance to tune it to a particular frequency. Other parameters like height above ground, proximity to metal objects, quality of ground and a few dozen other monkey-wrenches in the works will change the reactance. My 77 turn coil with #18 wire used 86 feet of wire. I would *strongly* recommend you use at least #20 wire or larger to raise the "*self-resonant"* point of your coil. And don't even THINK of using litz wire for a slider coil. Litz is a multistrand wire with each wire insulated from the others. Start to sand litz wire for a contact area and a whole forest of hair-fine wires will fuzz up!



My slider coil has a distributed capacitance of 4.2 picofarads. The self-resonant point of this coil is 3.4 MHz, well above the frequencies of interest. The distributed capacitance cannot be *directly* measured with a meter. I used a grid-dip oscillator to determine the resonant frequency with the coil disconnected from anything, then calculated the capacitance with the known resistance, which *can* be measured with an inductance meter. Out of morbid curiosity you ask, "What happens when you go *above* the self-resonant frequency?" Well - the inductor will now "look" capacitive, and a capacitor in parallel with a capacitor does not make a very good tuned circuit!

Just Slidin' Along...

Okay, the coil is wound, how do you make the slider? You need to take a trip to your local hobby shop or hardware store for small-diameter brass square tubing. I used 1/4-inch square tubing for the slider rail and a short (1/2-inch) piece of 9/32-inch square tubing for the slider itself.

This tubing is made to slide smoothly into the next size and being square, you do not have to worry about the feeler contact rotating out of place.

The slider rail is mounted above the coil using spacers. I used 3/8-inch metal spacers. One end has a solder terminal secured to the end of the rail. the other coil contact is connected to the end of the coil winding. The other end of the winding is not connected to anything; it "floats". I used a wooden knob threaded to a screw soldered to the top of the slider. From the bottom of the slider extends the feeler contact. This is made from a bit of tin-can or other thin metal that is springy. The feeler must contact an area of the coil that has had the enamel sanded away so that electrical contact will be made. In my model, with the connections on the left, the coil will *increase* in inductance. As you can see in Figure 1 the response is quite non-linear.

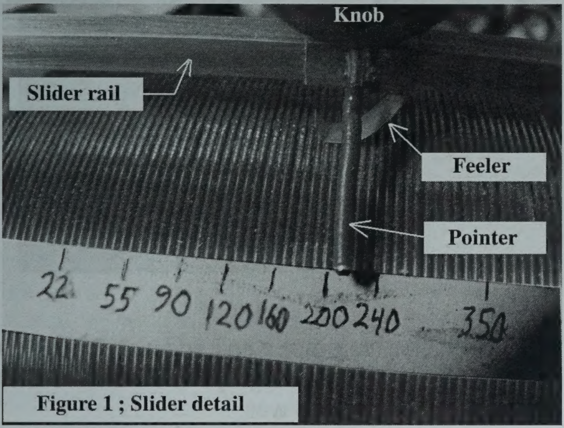


Figure 1 ; Slider detail

So Now What?
The slider won't do much good unless it is used with a receiver. Time to knock together a crystal set. In perusing the schematic in Figure 2, it comprises a plain-vanilla crystal set but with 2 differences. Figure 3 shows the differences. First; you may notice that the tuning coil is hanging a ways off the chassis. This is to allow the tuning coil to be placed inside the slider for maximum coupling. Second; There is a six -position rotary switch mounted at the end of the coil. This is the tap switch shown in the schematic. I also installed the option of using a detector diode or a cat-whisker detector. Not much rocket science here!

Operating the Whole Shebang:
Note to the newbies - The schematic shows the slider and the tuning coil sitting next to one another. I fell for this one when I was a newbie, sometime before rocks were invented. The two coils need to be *in line* with one another.

At maximum coupling the tuning coil will be *inside* the slider coil. Changing the mutual coupling is accomplished by varying the distance between the slider coil and the tuning coil. Changing the inductance of the slider coil will tune the antenna to the desired frequency.

I built this set with a tap-switcah. The same can be done with taps sticking up from the tuning coil and connected to the detector with a wire and alligator clip. By switching between taps the selectivity and sensitivity can be varied - inversely. This means at maximum sensitivity the set is at *minimum* selectivity. Connecting the tap to "40 turns" will increase selectivity but sacrifice sensitivity. It's a juggling act.

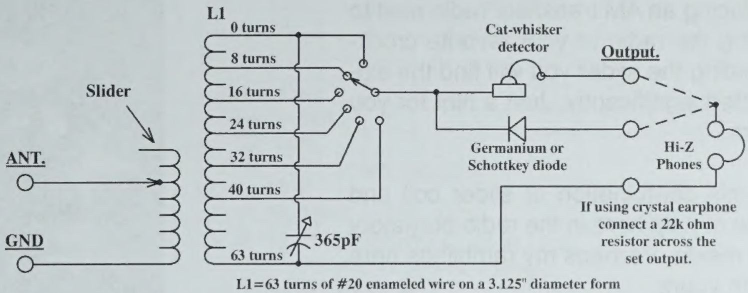

L1
0 turns
8 turns
16 turns
24 turns
32 turns
40 turns
63 turns
Slider
ANT.
GND
365pF
Cat-whisker detector
Output.
Germanium or Schottkey diode
Hi-Z Phones
If using crystal earphone connect a 22k ohm resistor across the set output.
L1=63 turns of #20 enameled wire on a 3.125" diameter form

Figure 2 : The Schematic

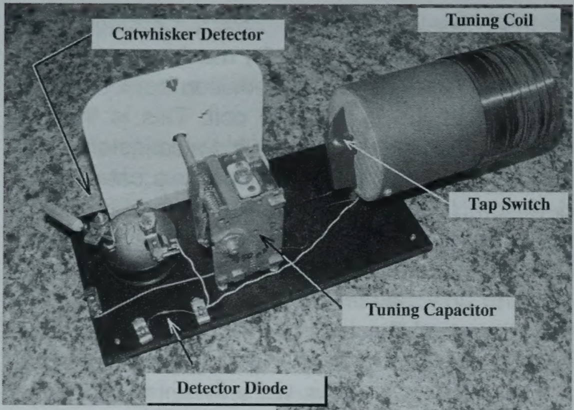


Figure 3: The Crystal Set

Why two different detectors? Because they *are* different. I can evaluate galenas and pyrites with the cat-whisker detector or test different diodes as detectors. I find the 1N5817 Schottkey diode works at least as well as the venerable germanium diode.

So everything is in place. The antenna and ground are connected to the slider. Headphones are connected to the output, at first using the diode. Set the tuning coil about half-inside the slider and the tap switch at maximum sensitivity (0-turns) and look for a station. If you live in a town that has more than one cop there should be a local you can pick up. Now adjust the slider for maximum volume. Setting the tap switch down towards maximum selectivity should enable you to separate stations.

By the way - placing an AM transistor radio next to the slider, tuning the radio to your favorite crock-jock, then adjusting the slider you will find the signal being boosted significantly. Just a hint for you AM-DX chasers.

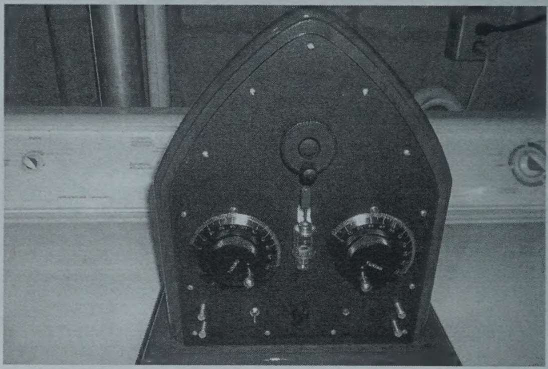
I have found this combination of slider coil and crystal set to be of help here in the radio purgatory in which I now reside. Perhaps my ramblings here may help you in yours.

Keep experimenting

Amplified Crystal Cathedral

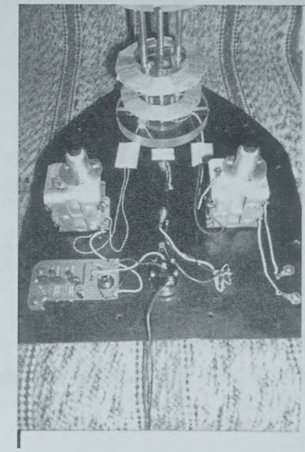
Larry Jeffers

I usually strive to build sets without batteries, but 70 year old ears make many stations come in low, even with sound-powered phones. This set won FIRST PLACE in the "homebrew" category at the Northland Antique Radio Club "Radio Daze 2015."

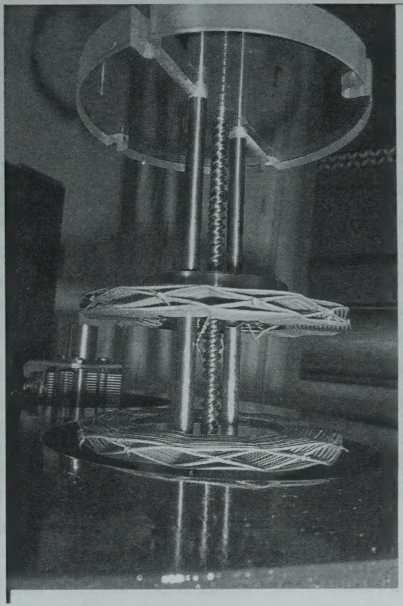


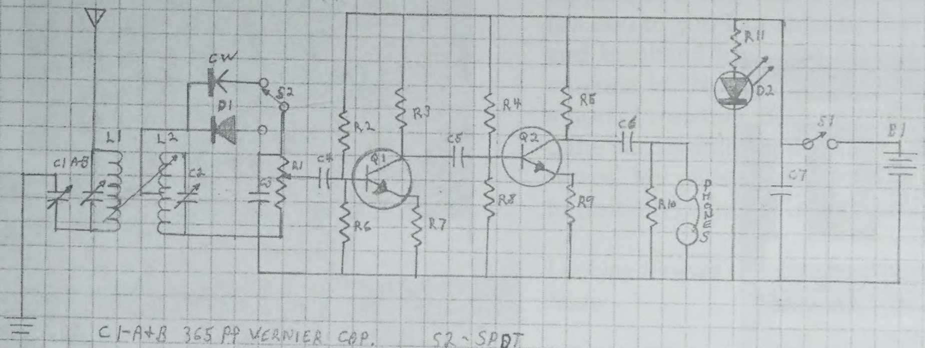
Another Society member, Ken Ladd won SECOND PLACE in the same category which shows that the Society is alive and well.

My cathedral set has all mahogany wood parts with a base of 5 1/4 inches wide and 10 1/2 inches deep. The front board is 12 inches wide, 141/2 inches high, and 1 1/8 inches thick. The adjustable coil coupling is made with a 1/4 inch masonry bit that has a ball bearing follower giving movement of one inch to four turns of the crank.



There are also some hand made parts in the coupler assembly. The cat whisker detector, binding posts and hubs to mount the dials were machined from brass. The brackets on the rear of the tuning capacitors were machined from aluminum. The dust covers are four inch PVC pipe with pipe caps. Any magnetic phones will work well from telephone receivers on up to good old vintage phones of any kind. Was this project fun? YES! Is it overkill?....Maybe.





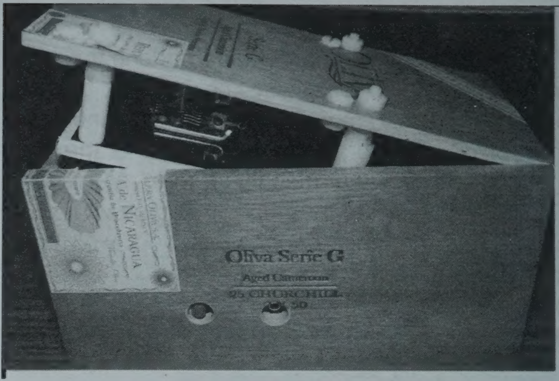
C1-A+B 365 PF VERNIER CAP.
C2-365 PF VERNIER CAP.
C3-.001 MFD.
C4,5+6-.1 MFD.
C7-100 MFD.
R1-500K WITH S.W. S1
R2-R4 470K
R3-R5 10K
R6-R8 47K
R7-R9 560
R10-100K
R11-350

S2-SPDT
D1-OA74A
D2-LED
CW-CAT WHISKER DETECTOR
B1-9V.
L1-52 TURNS 165/46 LITZ.
L2-52 TURNS-TAP AT 26 165/46 LITZ
COILS WOUND ON 2" DIA. 11 SPOKE MANDREL-SPOKES 3/16"

MK484 in a Cigar Box

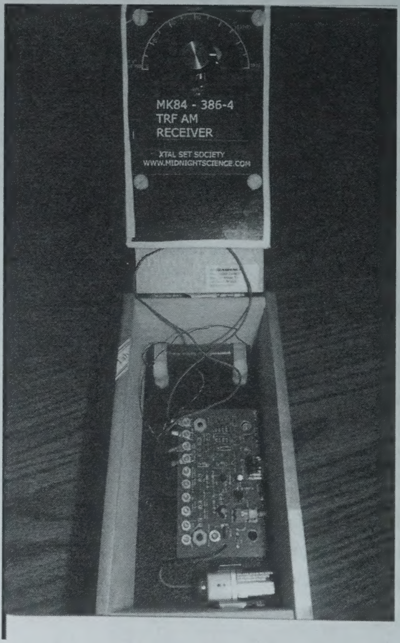
Lewis Ball

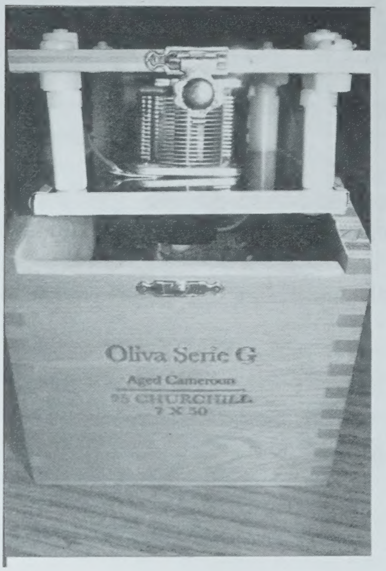
I took your challenge to modify a MK 484 a.m. radio mini kit. The challenge was do I modify the cigar box or change the layout of the kit. The box was too nice to change leaving only one choice. I made the following changes some of the decals I photocopied and enlarged so that I could use them near the air variable capacitor. I cut a 1/8 inch black plastic sheet to fit inside the box. I also cut one quarter inch clear plastic to fit on top of the black plastic.

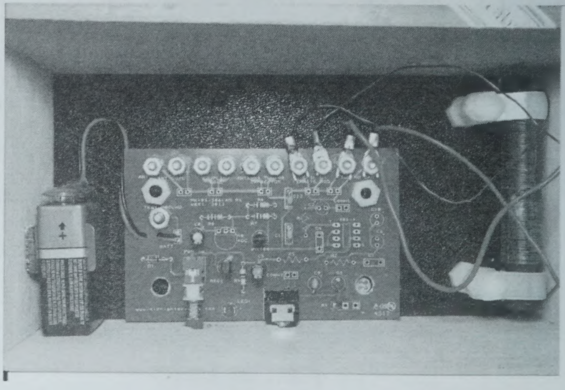


I placed the front panel copy between the two sheets of plastic below that the capacitor in place and mounted it on the lid. I also had one 1/8 black plastic sheet cut to the same size as the box and placed it on rails near the bottom of the cigar box. To that I mounted the ferrite rod antenna on the hinge end of the box.

To the circuit board I made modifications using 4 - 40 x 3/8" bolts placing them in the 10 solder points. I placed 4-40 nuts on the bolts of the board, the bottom. one being tight the upper one being left lose so I can use a spade lug so I can change capacitors or antennas just by taking the original ones out and replacing the new components.







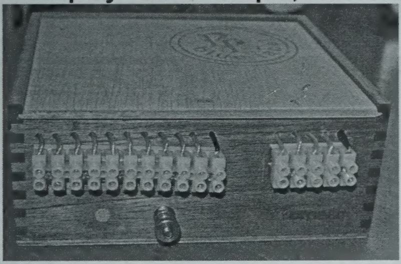
Xtal Corner: Member Correspondence

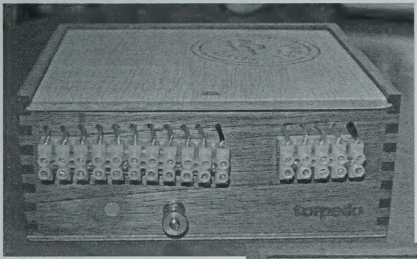
Patricia, Today. The teachers and high school kids That will be mentoring the 4th graders through Building the kits, came together as part of our 2015-16 planning retreat. They were all like kids!

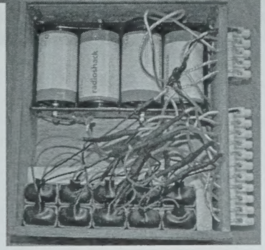
3 of the 6 radios worked. They took the rest home Determined to make them work. I can't wait till next Week. Thanks for helping me make this possible.
Alma Ripley

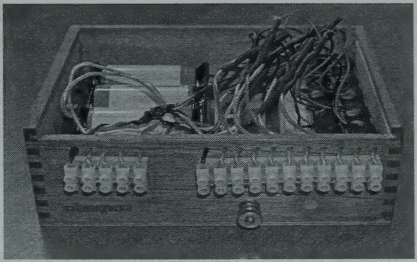
I just finished my CIGAR BOX TUBE RADIO POWER SUPPLY. The P/S provides 1.5, 3.0, 4.5, 6.0 vDC from "D-cells" for tube filaments and 9, 18, 27, 36, 45, 54, 63, 72, 81, 90 vDC from snap-top 9 volt transistor radio batteries for plate and grid voltages.

It is a bit crude. But I am only a rookie at this wood-working stuff. Finishing touches in the form of labels are the only thing yet to be added. Hope you like the pix, Ron Sindric









Hello Patricia
I've been trying to find an answer to what I'd think would be a simple question. Folks I've written have replied with "don't know" up to and including "too complicated and not worth my time to investigate". So, I'd thought I'd give you and the technical staff at the Xtal Set Society a shot at it. Here goes ...

There are lost of pages on the Internet that discuss how to make air core and toroid baluns. The one issue that none seem to discuss is how many turns of wire you wind onto the core.

I want to make a 9:1, air core, balun for a couple of antennas. One is a random length antenna (approx 100 feet) that is up in the air. The other is a 200 to 300 foot antenna that is strung across, and insulated from, the ground (far end of this antenna is *NOT* connected to ground through a 500 Ω resistor). Both antennas have been used quite successfully on the long- medium and short waves. My question is: How many turns of wire to (initially) wind on the core to make the balun?

Looking forward to your comments and thoughts ...
John

John,

One source for "technical stuff" that is often overlooked is the ole Amateur Radio Handbook......... most any edition....Mine is 2004 but these don't change much.

Look in the index for unums and baluns..........

A "balun" (balanced to unbalanced) is a device that matches a source to a load or a load to a source, wherein one is unbalanced and one is balanced. A popular example is coax (from a transmitter) feeding a dipole antenna. The Dipole is balanced and the coax is unbalanced. This type of balun is useful in that it "matches" the source and load and prevents current from returning back to a transmitter.

Another confusing piece of equipment - but very handy for those in the know - is the common mode choke (CMC). This device is often used to reduce noise from a source that would otherwise add noise to a driven load.

I'm way behind on a number of projects time wise right now so don't have time to write a paper on these.

I may be forced to look at your question, since I am trying to reduce the level of HF noise coming into my station which consists right now of an Elecraft K3, P3, and SteppIR vertical. One solution is to use a Beam antenna......but my space is restricted in distance and height (city restriction above 33 feet!).

I may try fiddling with a Beverage which has directional characteristics (pattern) and hence would reduce the noise received from the back side of the pattern and as such reduce the total noise received by the antenna.
Later, Phil, W0XI

Scrap Pile Radio

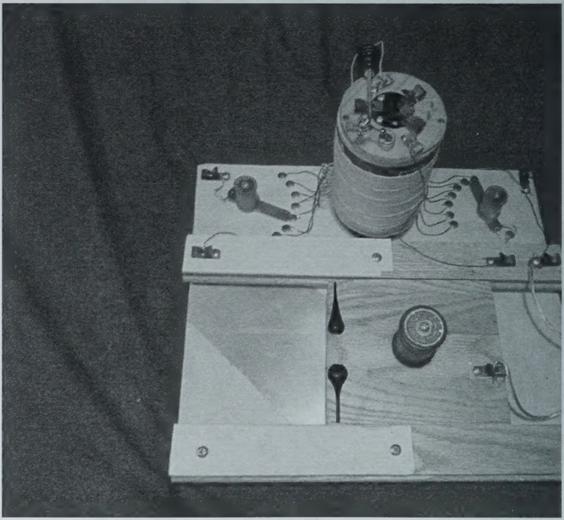
Ken Ladd

Imagine for a moment that it is the dead of winter and you are in a remote cabin in Canada in the early days. You slip your headphones on and make an adjustment or two on the crystal set you just finished building and you hear someone singing Annie Laurie. John Rowland's (1892 to 1972) did just that as he described in his 1947 book Cache Lake Country.

I read his book about 40 years ago and finally got around to building the radio he described. A radio engineer drew up a plan for him and provided a set of headphones and a diode detector. He left it up to John and his friends to find all of the other materials. These included foil from a tea box to build the sliding variable capacitor and wire from an engine ignition coil that they found when the snow shoed to an abandoned mine site.

I used .010 aluminum instead of foil and picked up on the theme of "scrap pile" concept. The only items that I purchased were brass thumb tacks and 8 screws. The plates of the capacitor are mounted at 45 degrees which allow for finer tuning. I used a 1n34A and for looks a steel galena crystal that I bought from Elmer Osterhoudt back in the day. There was a typo in the book which called for 166 turns on the coil which should have been 116. There was also a dimensional error and the diagram was also incorrect and incomplete. I used hardwood floor scraps for the rail and slider. After I glued the slider scraps together it was bowed and too thick so I ground it down on the concrete patio. I used pastry packaging to insulate the capacitor.

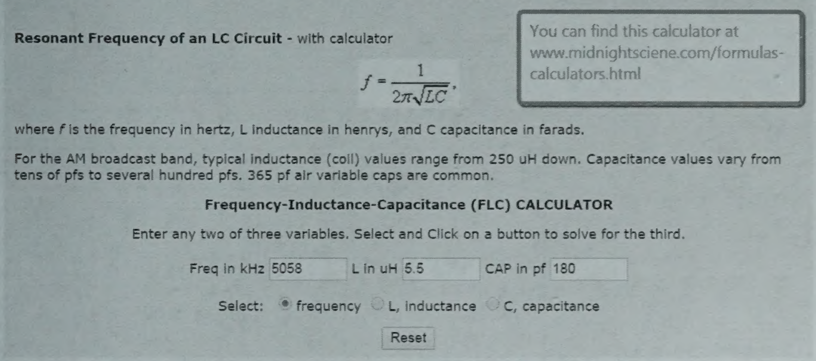
As expected the set is not very selective. Operating it here in Minneapolis makes it hard to judge the sensitivity. Mother Earth News republished the plan but I doubt it was ever built until now.



Broadcast (AM) Band and Short Wave Band Coil Values and Sizes

By Phil Anderson, W0XI

We often receive the question, “What size coil should I use for a shortwave crystal set?” This question implies, of course, that the hobbyist inquiring has probably built one or more AM band crystal sets already. Rather than simply state a specific answer for a given HF frequency, we’ve found it more helpful – and educational – to outline how to reason/calculate roughly what the coil dimensions should be for a given HF frequency. Let’s start with the formula for inductance given that the frequency and capacitance for the circuit are known. The coil inductance value in micro-henry (uH) can be found by plugging in the frequency in kilohertz and the capacitance in pico-farads. For example, as shown below, I plugged in 5000 kHz and 180 pf, obtaining about 5 micro-henry (uH) for the coil.



Resonant Frequency of an LC Circuit - with calculator

$$f = \frac{1}{2\pi\sqrt{LC}},$$

where *f* is the frequency in hertz, L inductance in henrys, and C capacitance in farads.

For the AM broadcast band, typical inductance (coil) values range from 250 uH down. Capacitance values vary from tens of pfs to several hundred pfs. 365 pf air variable caps are common.

Frequency-Inductance-Capacitance (FLC) CALCULATOR

Enter any two of three variables. Select and Click on a button to solve for the third.

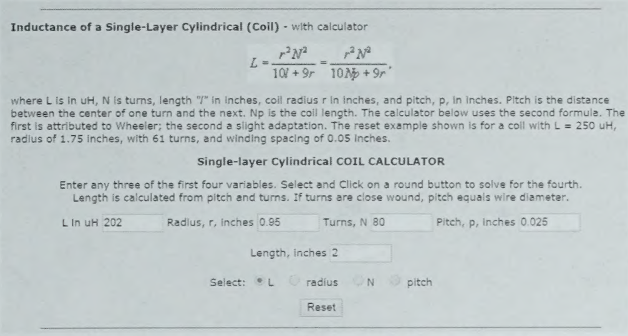
Freq in kHz 5058 L in uH 5.5 CAP in pf 180

Select: ● frequency ○ L, inductance ○ C, capacitance

You can find this calculator at www.midnightsciene.com/formulas-calculators.html

If I had tried a much larger value for the coil, such as 250 uH, then the capacitance would have been just a few pf. Clearly one cannot build a circuit with a capacitance so small. First of all, you hand capacitance would totally detune the radio. Also, the capacitance of two short pieces of wire next to each other would also exceed this value. As we go up in frequency we must maintain a reasonable value for a tuning capacitor, say 50 pf or more. ***Hence, the inductance MUST be drastically reduced as our frequency of use goes up!***

Given that 5 micro-henry (uH) is an adequate value, let’s use our coil formula shown in the second figure below to see what the size and number of turns such a coil should have. This calculator can be found on our website at the URL listed in the upper right of the first figure. To get the 5 uH we are looking for, I tried several values for the radius of the coil, turns and pitch. Then clicked on L to get the coil value given these inputs. Note that one value that works is a radius of 0.9 inches, 14 turns, with the spacing of the turns at 0.15 inches. The formula also displays the length of the coil. Hence a 5 uH coil for 5,000 kHz has a 1.8 inch diameter (a 1.5 inch piece of PVC pipe will do here as a form) and 14 turns spread out over 2.1 inches. By the way, the Q for a given air core coil is about optimal when the length-diameter ratio is about 1/1. It turns out that this coil size and value is what we used in our Marconi Short-Wave Crystal Set! I hope this was helpful. If you haven’t used these formulas before, go to our website and experiment with them.



Inductance of a Single-Layer Cylindrical (Coil) - with calculator

$$L = \frac{r^2N^2}{10l + 9r} = \frac{r^2N^2}{10Np + 9r},$$

where L is in uH, N is turns, length "l" in inches, coil radius r in inches, and pitch, p, in inches. Pitch is the distance between the center of one turn and the next. Np is the coil length. The calculator below uses the second formula. The first is attributed to Wheeler; the second a slight adaptation. The reset example shown is for a coil with L = 250 uH, radius of 1.75 inches, with 61 turns, and winding spacing of 0.05 inches.

Single-layer Cylindrical COIL CALCULATOR

Enter any three of the first four variables. Select and Click on a round button to solve for the fourth. Length is calculated from pitch and turns. If turns are close wound, pitch equals wire diameter.

L in uH 202 Radius, r, inches 0.95 Turns, N 80 Pitch, p, inches 0.025

Length, inches 2

Select: ● L ○ radius ○ N ○ pitch

THE XTAL SET SOCIETY

7-1-15

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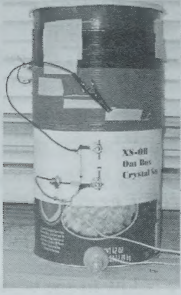
Oat Box Radio Pack 1



Build an inexpensive radio out of an oat meal box. The pack includes 1 Spool (100 feet) #24 wire, 1 IN34 Diode, 1 100 pf Capacitor, 1 47K Resistor, 3 alligator clips, 1 ceramic, hi impedance ear piece, 6-32 by ½ machine screws, 6-32 nuts, 5 #6 solder lugs -- you provide the box (eat the oatmeal, it's good for you!) and an antenna. The plans for this radio are on our website at www.midnightscience. com. Great for classes and scouting -- easy for kids to put together. If you need antenna wire, then order the Oatbox Pack 2. **Cat# OB1 $14.95**

Oat Box Radio Pack 2

This has all the parts of our OB1 kit, but includes an extra roll of wire for the antenna. **Cat# OB2 $19.95**

The Little Wonder Crystal Radio Kit

Our "Little Wonder" is a super starter kit for kids and beginning adult builders! It tunes the entire broadcast band. The extra large solder pads make it easy for beginning builders to have a successful first radio. There are only a few solder joints, and the pads are spread out making it clean and simple to assemble. The "Little Wonder" was designed especially for the XSS by our founder, Grampa Phil, W0XI. We tried to combine everything we've learned about building radios with beginners and kids to create a radio that everyone can build the first time. There is no coil to wind, a high resonant frequency molded choke has been used in place of the coil. A nice photo diagram is included showing all the parts and their placement on the printed circuit board. (PCB) This radio is perfect for parents and grandparents to build with kids. It is also priced right for classroom use, and can be used to teach basic radio theory, soldering, and handling of electronic parts and PCB's. Kit includes a high impedance crystal earplug. A great little kit; you've got to have one! Cat# XS402 $19.95

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